Two Green Giants: Factors Affecting CSO Control through Green Infrastructure

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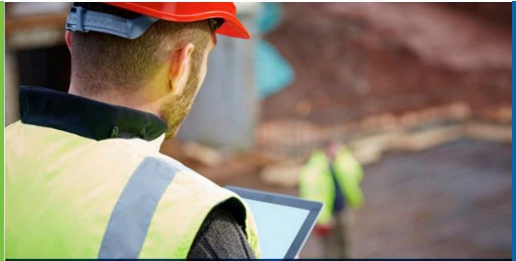
10:30 am


Smarter Infrastructure


Ohio Green Infrastructure


Creating Resiliency

Water Partnership with CDM Smith

Precious resources. Powerful insights. A future we build together.

Today's Presentation

- Green Infrastructure 101
- Key Planning Considerations
- Key Design Considerations
- Key Construction Considerations
- Lessons Learned
- Questions

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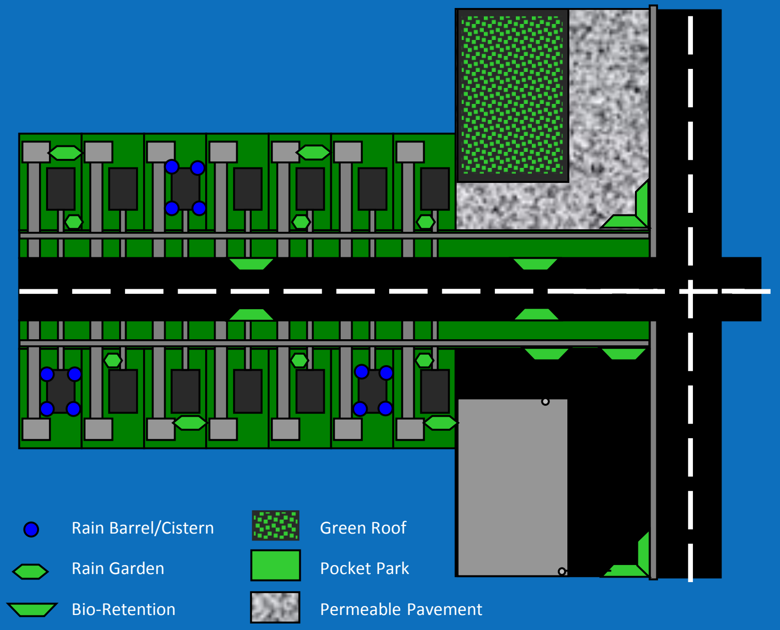
What is “Green” Stormwater Infrastructure?

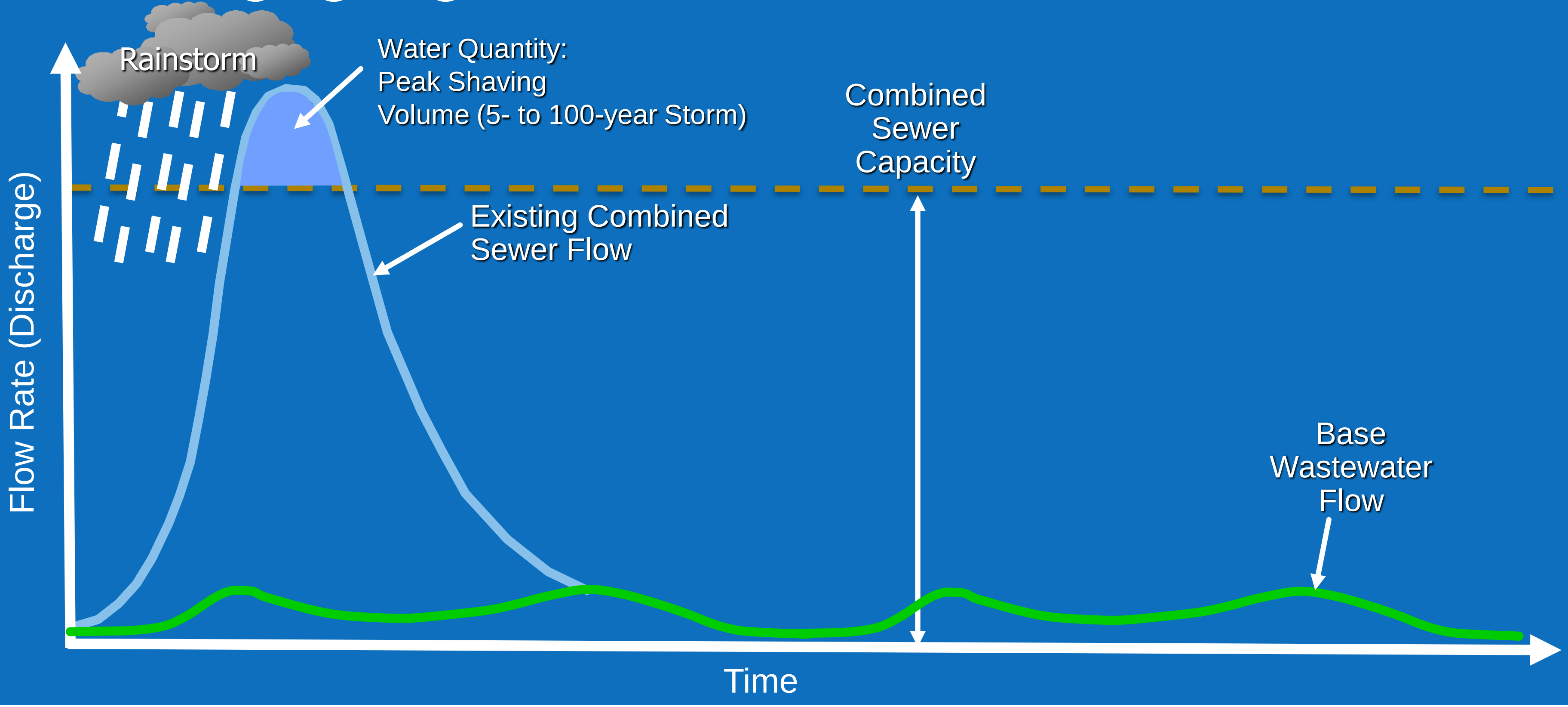
- Vegetated (except when it’s not)
- “Off the Grid” (where feasible)
- Decentralized (unless regionalized)
- Less expensive (Really!?)
- Controls pollution (except when discharged to combined systems)
- Supports “livable” communities (if sustainable)
- Not a pond (unless it’s a wetland)



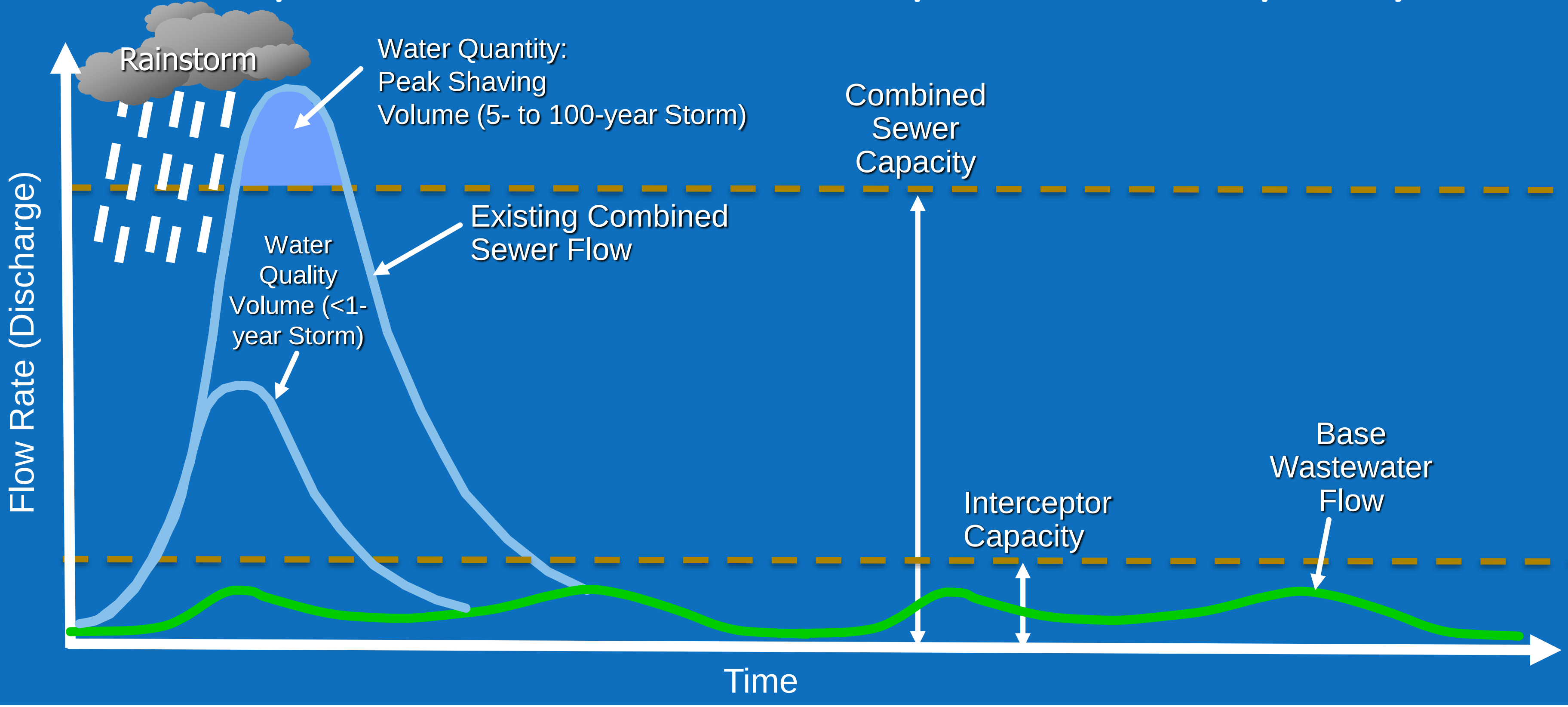
“An adaptable term used to describe an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality and provide utility services”

U.S. EPA “Managing Wet Weather with Green Infrastructure” Website, glossary of terms

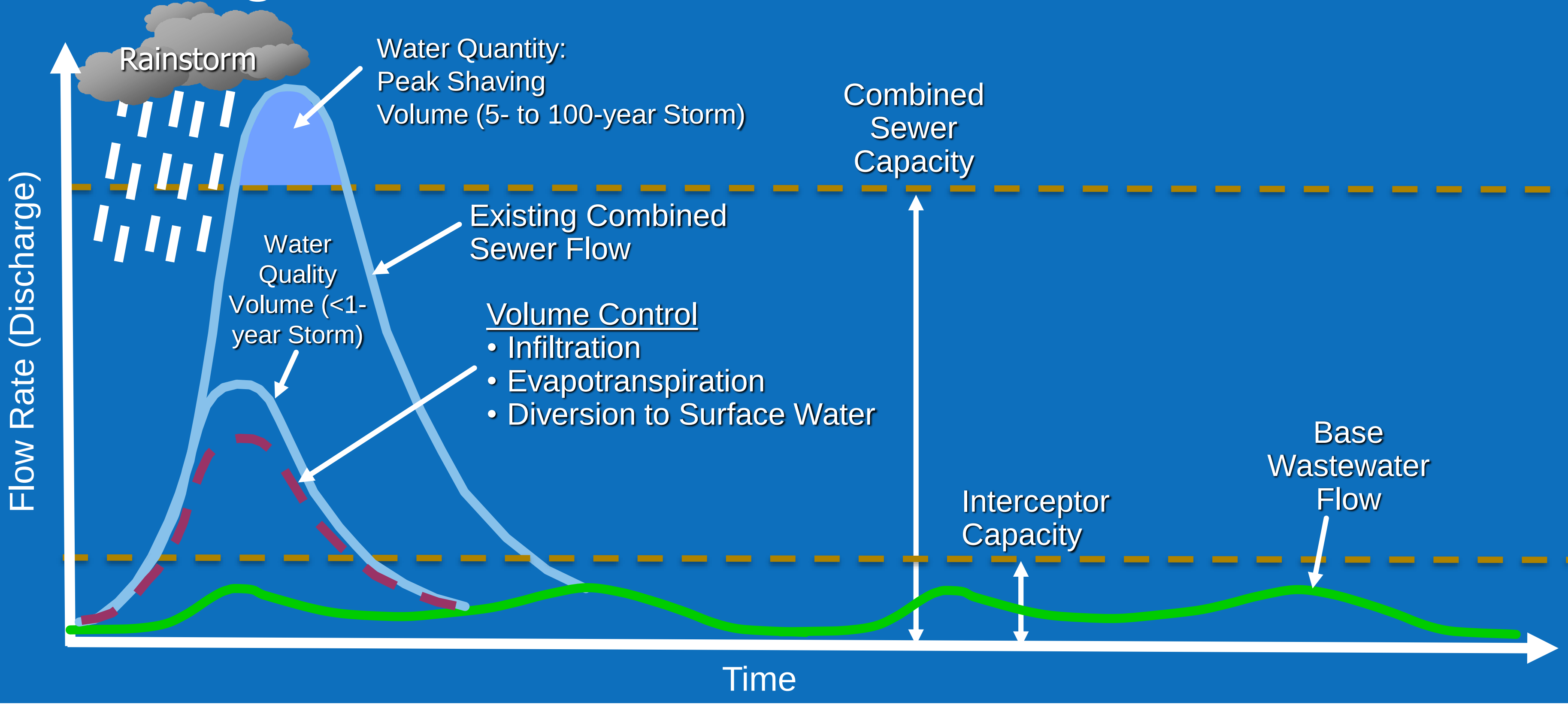
Traditional stormwater control strategies are effective at managing larger storm events . . . .



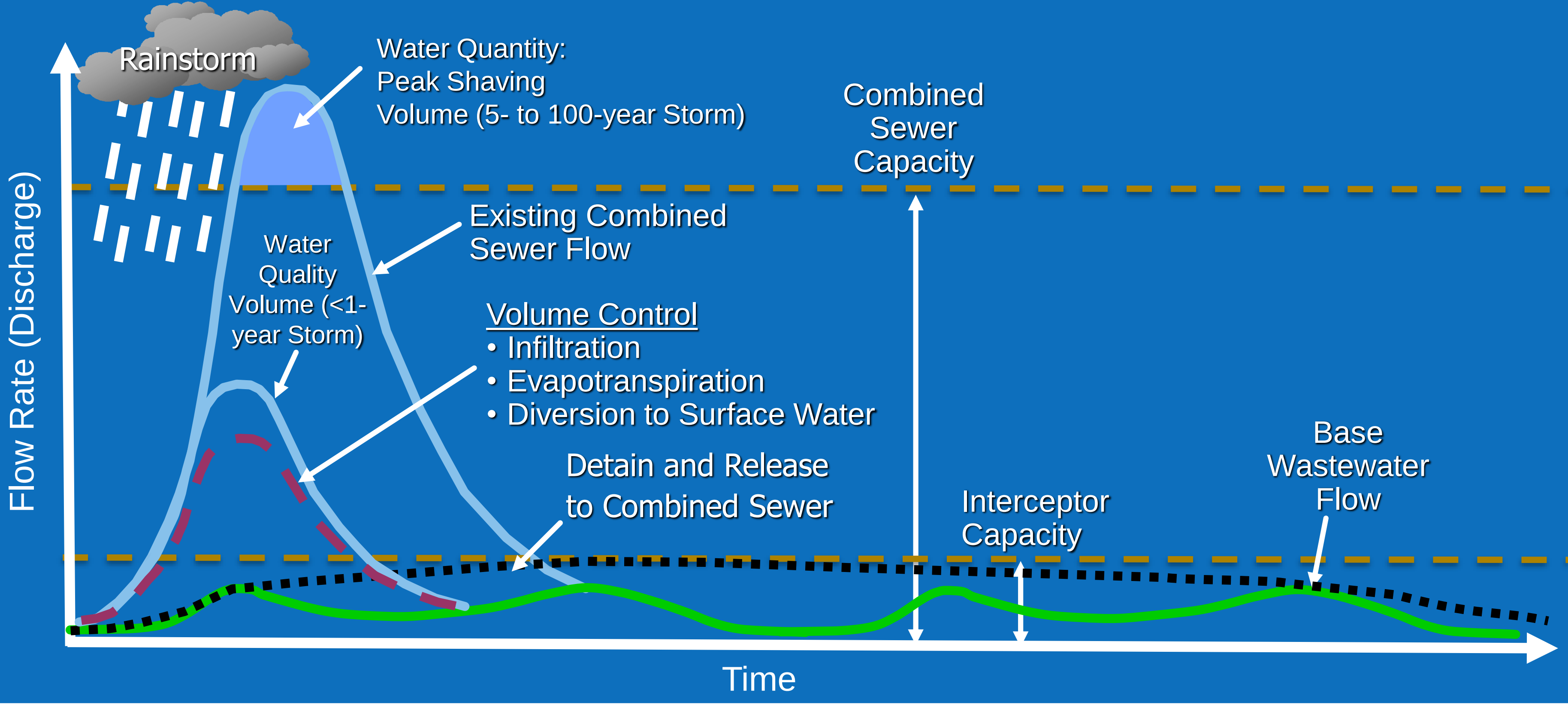
. . . . while alternative strategies are needed to manage small frequent storm events to improve water quality.



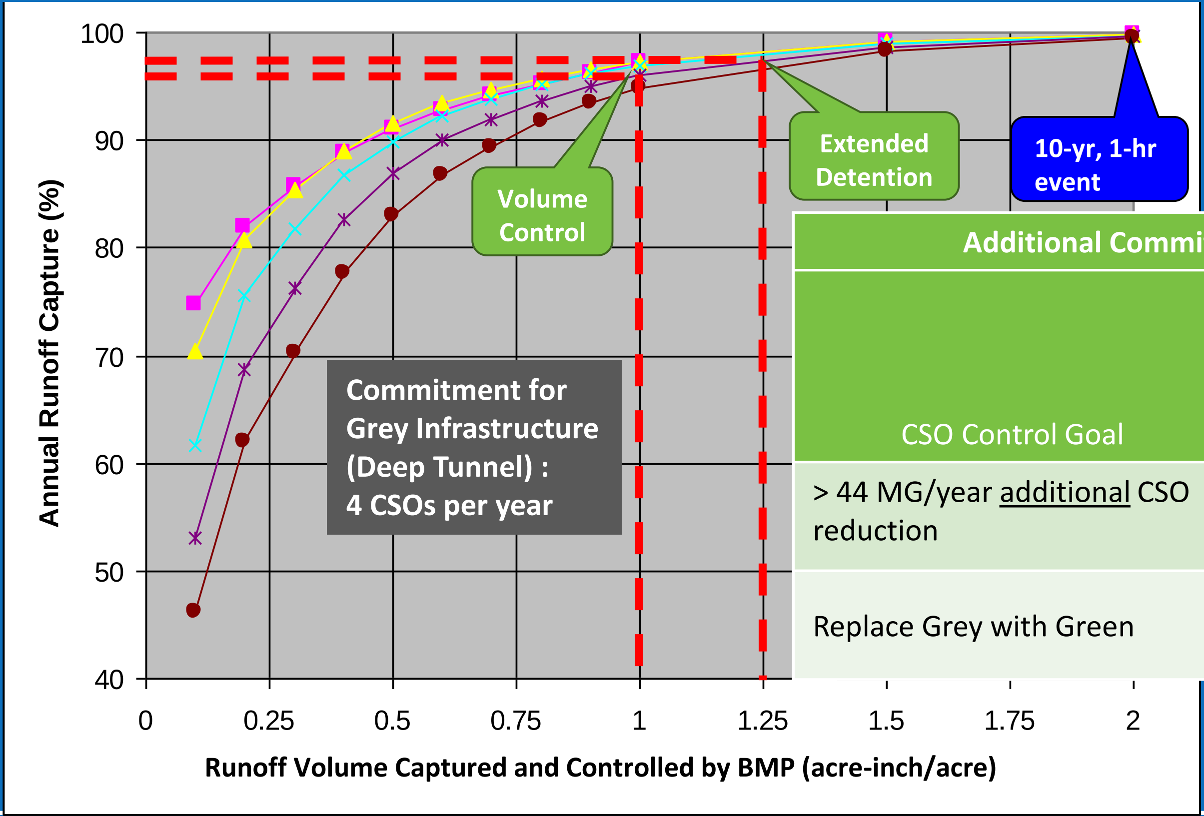
Green stormwater controls restore natural hydrology by removing volume, but where not feasible . . .



. . . may incorporate extended detention to compensate for increased volume.



Long-term continuous simulation reveals cost-effectiveness of wet weather control strategies.



Additional Commitment to Green Infrastructure		
	Green Infrastructure Strategy	
CSO Control Goal	Reduce Volume to Combined Sewer	Detain and Release to Combined Sewer
> 44 MG/year additional CSO reduction	💧	💧
Replace Grey with Green	💧	💧

East 140th St. Consolidation and Relief Sewer Project (E140CRS)

Original Relief Sewer Concept

- 15,275 ft of tunnel (48-inch to 102-inch)
- 12 work shafts/drop structures
- 6,070 feet of open cut sanitary relief sewer (24-inch to 60-inch)
- Estimated Cost: $109M

Green Infrastructure Opportunity

- Large areas of separate storm and sanitary sewers
- Two major culverted streams
- Is green infrastructure a cost-effective alternative to grey infrastructure?

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Relief Sewer with Green Infrastructure

- 14,200 feet of new storm sewer redirects 223 acres to three green infrastructure basins (4.6 MG total)
- Eliminates 6,300 feet of large-diameter relief sanitary sewer and 3 of 12 work shafts to tunnel.
- Reduces remaining relief sewer 1-2 pipe diameters
- Reduces average annual CSO volume 7.5 MG (17 percent of Districtwide goal)
- Reduces project cost $19M (18 percent), or $2.06 per gallon removed.

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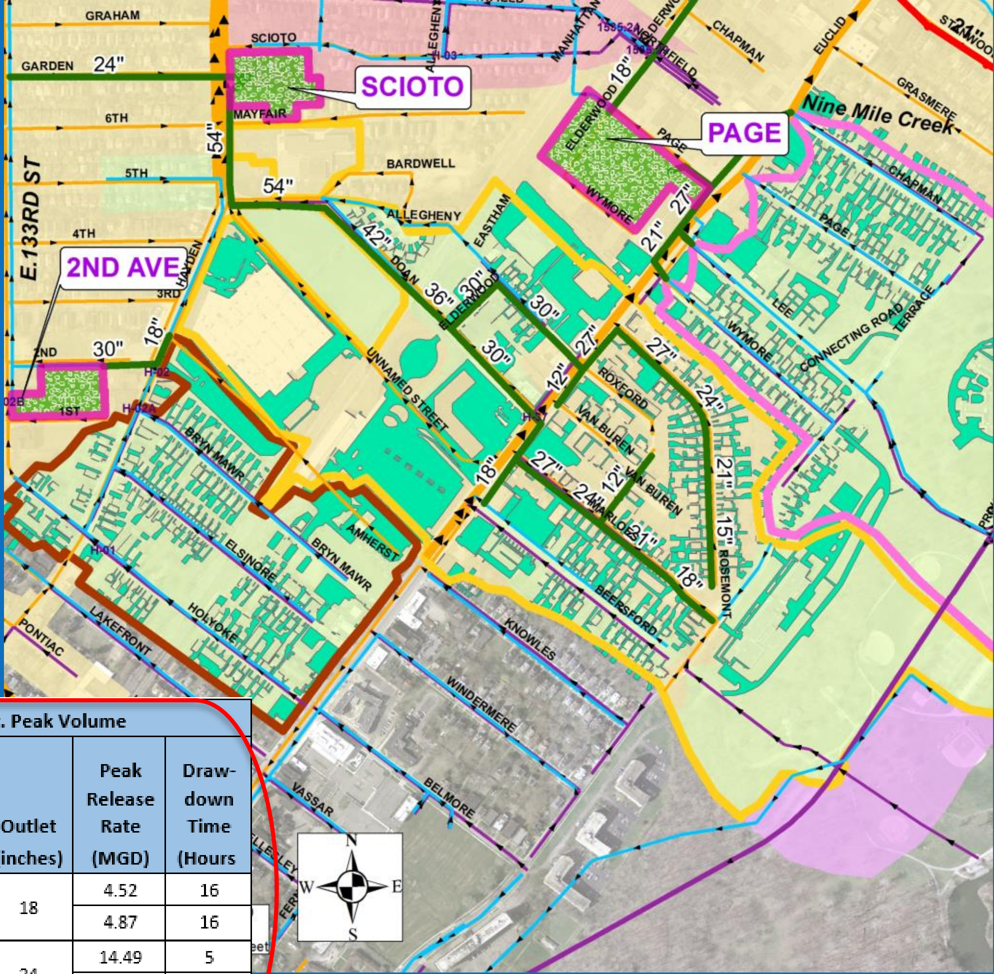
E140CRS Stormwater Facility Basis of Design

- 5-year storm detention to meet culverted stream capacity

Stormwater Management Area Name	Land Use Condition	Drainage Area (Acres)		Re-Directed Stormwater		Receiving Storm Sewer / Stream			
		Total	Impervious	Peak Design Flow (MGD)	Equivalent Diameter (inches)	Location	Full Flow Capacity (MGD)	Diameter (inches)	Distance (feet)
Page	Existing	86	15	47.4	60	Shaw Brook @ Elderwood	74	60	1,356
	Future		23	60.9	66				
Scioto	Existing	102	20	68.4	54	E133rd St. @ Garden	19	36	1,866
	Future		38	86.9	60				
Second Ave.	Existing	35	6	13.5	24	E133rd St. @ 2nd Ave.	5.4	18	138
	Future		8	14.0	24				

Stormwater Management Area Name	Land Use Condition	Design Water Quality Control				5-Yr. 6 Hr. Peak Volume				
		Volume (MG)	Depth (feet)	Peak Release Rate (MGD)	Draw-down Time (Hours)	Volume (MG)	Depth (feet)	Outlet (inches)	Peak Release Rate (MGD)	Draw-down Time (Hours
Page	Existing	0.27	0.87	0.83	25	1.85	3.9	18	4.52	16
	Future	0.36	1.10	1.00	24	2.16	4.4		4.87	16
Scioto	Existing	0.35	1.09	3.69	27	1.68	4.6	24	14.49	5
	Future	0.55	1.68	4.82	25	2.12	5.6		15.80	5
Second Ave.	Existing	0.11	1.07	0.77	26	0.29	2.6	18	5.46	4
	Future	0.13	1.26	0.93	24	0.33	3.8		6.16	4.5



E140CRS Stormwater Facility Basis of Design

- Water quality control for surface water release

Stormwater Management Area Name	Land Use Condition	Drainage Area (Acres)		Re-Directed Stormwater		Receiving Storm Sewer / Stream			
		Total	Impervious	Peak Design Flow (MGD)	Equivalent Diameter (inches)	Location	Full Flow Capacity (MGD)	Diameter (inches)	Distance (feet)
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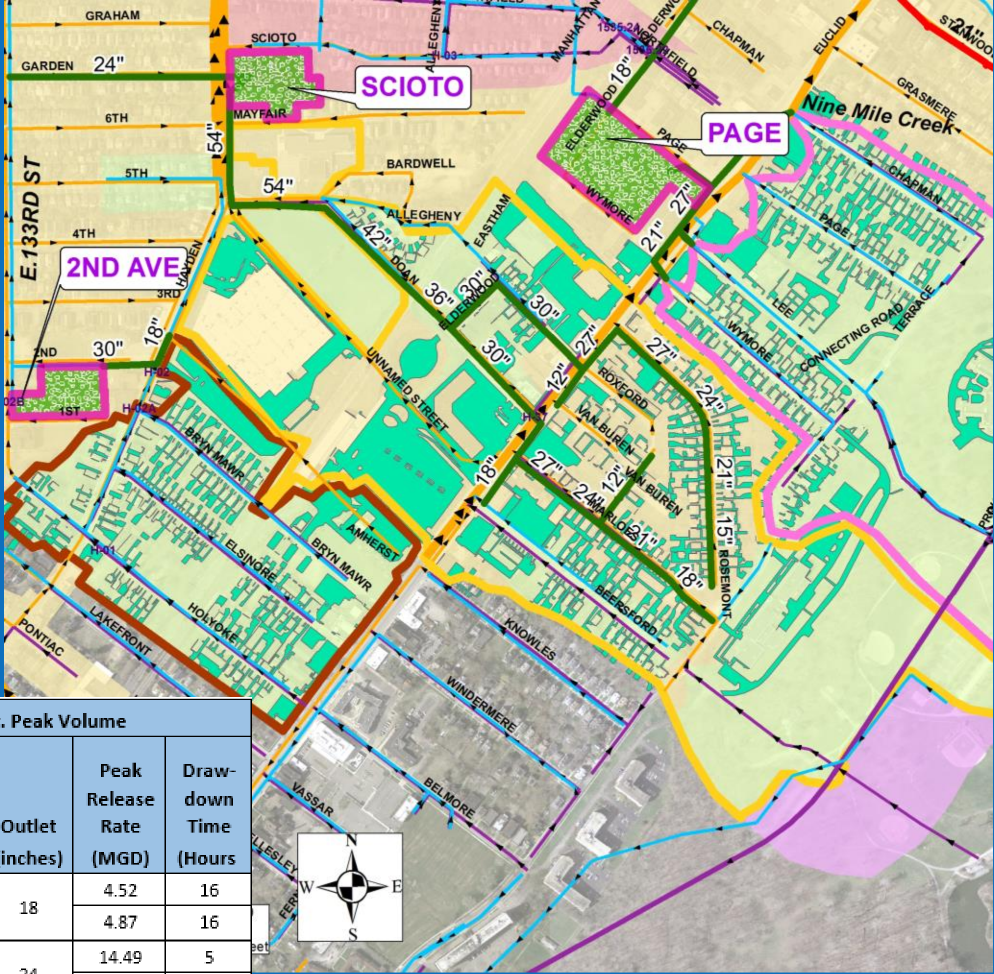
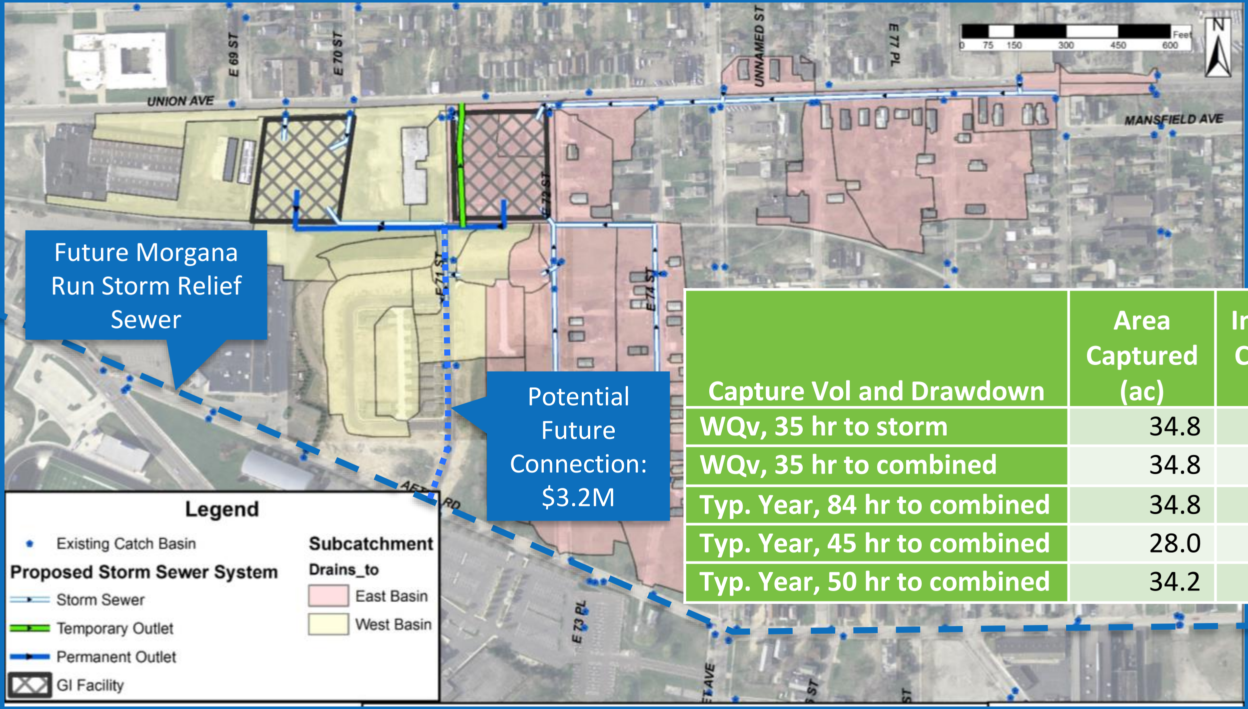


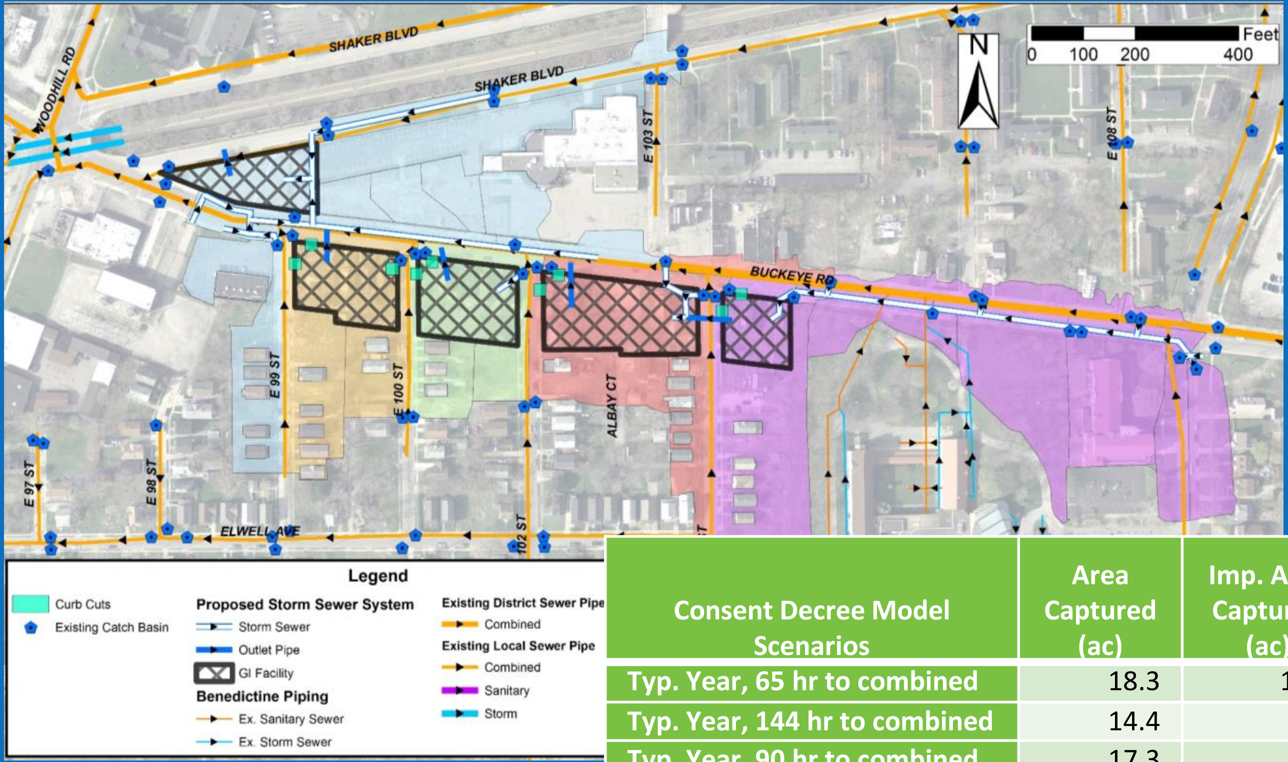
Key Planning Considerations

In Slavic Village – Union project area, effectiveness depends on future connection to surface water discharge.



Capture Vol and Drawdown	Area Captured (ac)	Imp. Area Captured (ac)	CSO Reduction (MG)	Cost ($M)	Cost/ Reduction ($/Gal)
WQv, 35 hr to storm	34.8	14.8	1.5	$7.8	$5.20
WQv, 35 hr to combined	34.8	14.8	0.0	$4.2	N/A
Typ. Year, 84 hr to combined	34.8	14.8	0.5	$4.2	$8.50
Typ. Year, 45 hr to combined	28.0	11.9	0.3	$3.8	$12.70
Typ. Year, 50 hr to combined	34.2	14.4	0.6	$4.1	$6.80

In Buckeye project area, minimal volume control limits CSO reduction, refocusing project on community benefits.



Consent Decree Model Scenarios	Area Captured (ac)	Imp. Area Captured (ac)	CSO Reduction (MG)	Cost ($M)	Cost/ Reduction ($/Gal)
Typ. Year, 65 hr to combined	18.3	10.0	1.0	5.11	5.11
Typ. Year, 144 hr to combined	14.4	8.5	1.0	4.84	4.84
Typ. Year, 90 hr to combined	17.3	9.6	1.1	5.05	4.59

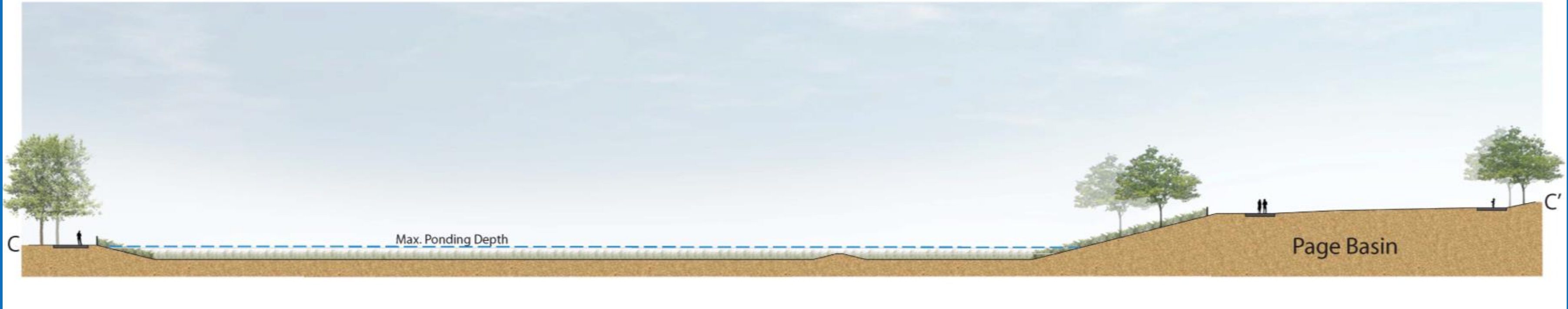
Key Design Considerations

Key Design Considerations

- Basin Design
  - Hydrology
  - Safety
  - Planting Design
- Programming
  - Engagement
  - Amenity Selection
  - Public Art

Hydrology

- Required storage volume derived from modeling to meet stormwater management objectives
- Basins must be "cut" from existing soil
- All slopes above the existing low point will be above the bioretention level
- Implications for placement, ponding depths, outlet control
- Basin floor determined by the invert of influent storm sewers or trench drains



Safety

- Basins constructed in dense urban locations
- Controlling the (over)flow

Outlet Control

Emergency Spillway at low point

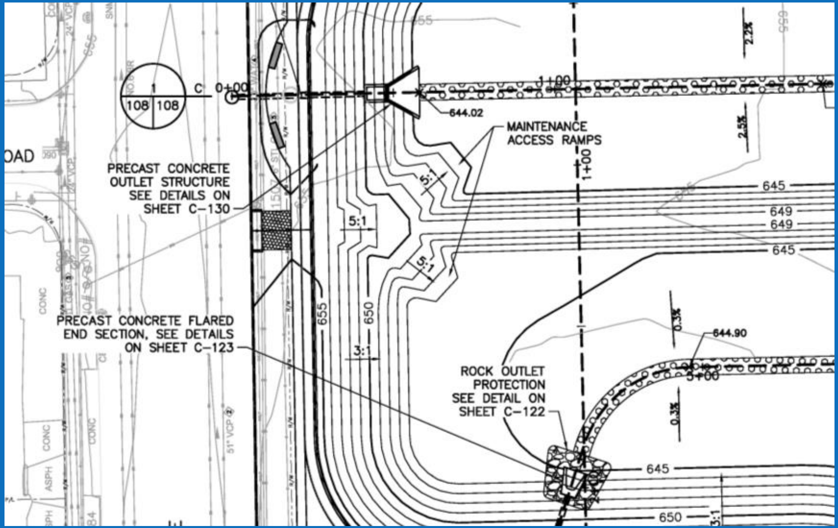
Safety – Pedestrian Restriction

Guardrails at 42" minimum

Planting –Shrub deterrent

Safety - Accessibility

- Internal access drives
- Maximum slopes 3:1
  - Max. safe slope for lawn maintenance machinery and human egress



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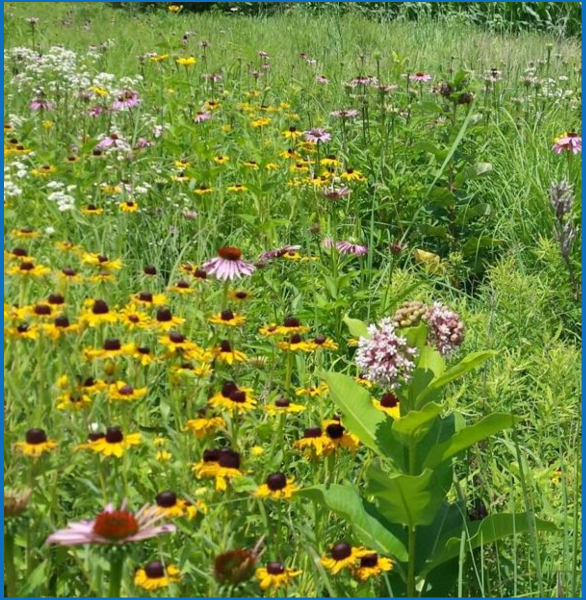
Planting Design – For The Basin

- Minimize Install & Maintenance Costs

Low Maintenance Grass

Sedge Meadow Mix

Basin Slope Seed Mix



Basin Floor Plantings

Wetland Plugs

Pros

- Immediate observable results

Cons

- High up-front material costs
- Complicated planting and growing process
- Challenging planting design
- Average loss of 20%

Wetland Seed Mix

Pros

- Low up-front material cost
- Easy installation
- Self-organization

Cons

- Establishment takes several seasons
- Susceptibility to invasives

- Key Design Considerations

Reducing Costs

- E-140th St. Relief Sewer Project
  - 3 basins
    - 130,500 sf of Basin Floor
    - 88,000 sf of Basin Slope
- Union Buckeye Project
  - 5 Basins
    - 49,500 sf of Basin Floor
    - 80,500 sf of Basin Slope

- Total: 4.13 Acres of Basin Floor
- Total: 3.87 Acres of Basin Slope

Seed Mix

- Low up-front material cost
- Easy installation
- Self-organization
- Low maintenance after establishment

Planning For Uncertainty

- Wetland Indicator Status

  OBL - Always occurs in wetlands under natural conditions

  FACW - Usually occurs in wetlands but occasionally in non-wetlands

  FAC - Equally likely to occur in wetlands or non-wetlands

  FACU - Usually occur in non wetlands but occasionally in wetlands

  UPL – Occur almost always in non-wetlands under natural conditions

- Constructed wetlands have complicated hydrology that is constantly in flux
- No matter how well a site is graded, there will always be inconsistency with plans
- Specially adapted plant species can tolerate varying states of saturation and drought

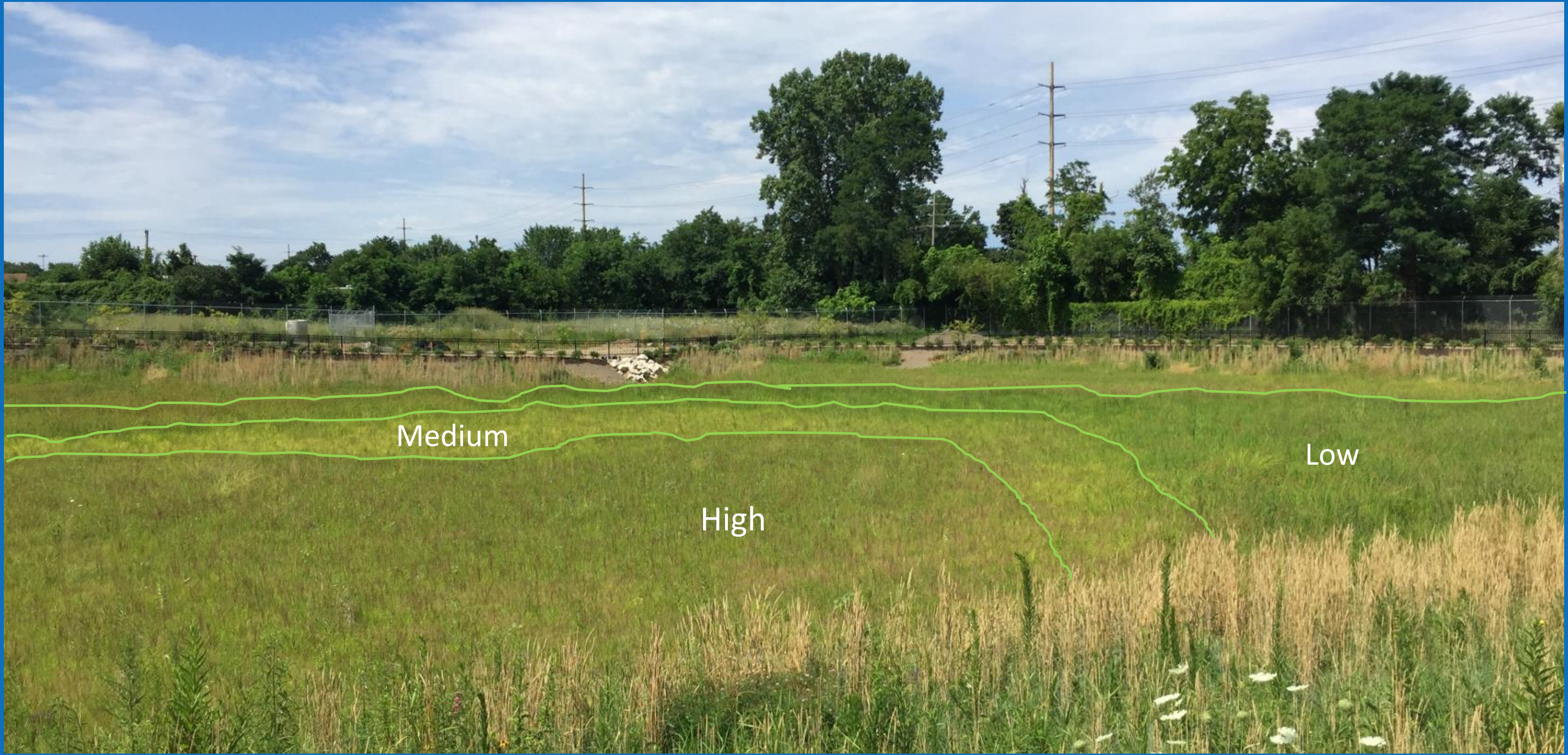
Diversity of Species

- Sedge Meadow Seed Mix
- Cover Crop

Self Organization

- Sedge Meadow Seed Mix in High Saturation Locations

Self Organization



Basin Slope Seed Mix

- E-140th Short Grass Meadow
- Cover Crop

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No-Mow Seed Mix

- Union-Buckeye Low Maintenance Turf Grass

TRM and Rip Rap

- Low Flow Channels – Inlets – Outlets – Spillways

Planting Design - Tree Selection

- Wetland tree species
- Utility Friendly species
- Plan for mature sizes

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Programming - Engagement

- Surface G.I. Challenges
  - Space
  - Land Use
  - Public Perception
  - Safety
- Opportunities
  - Green infrastructure is interesting - Showcase it!
  - Green infrastructure is compatible with urban park programming activities
- Shared land use is mutually beneficial
  - Utility for the owner
  - Utility for the community

Amenity Selection Process

- Open green space
- Accessible picnic areas
- Public plazas with seating
- Loop paths
- Outdoor Classrooms

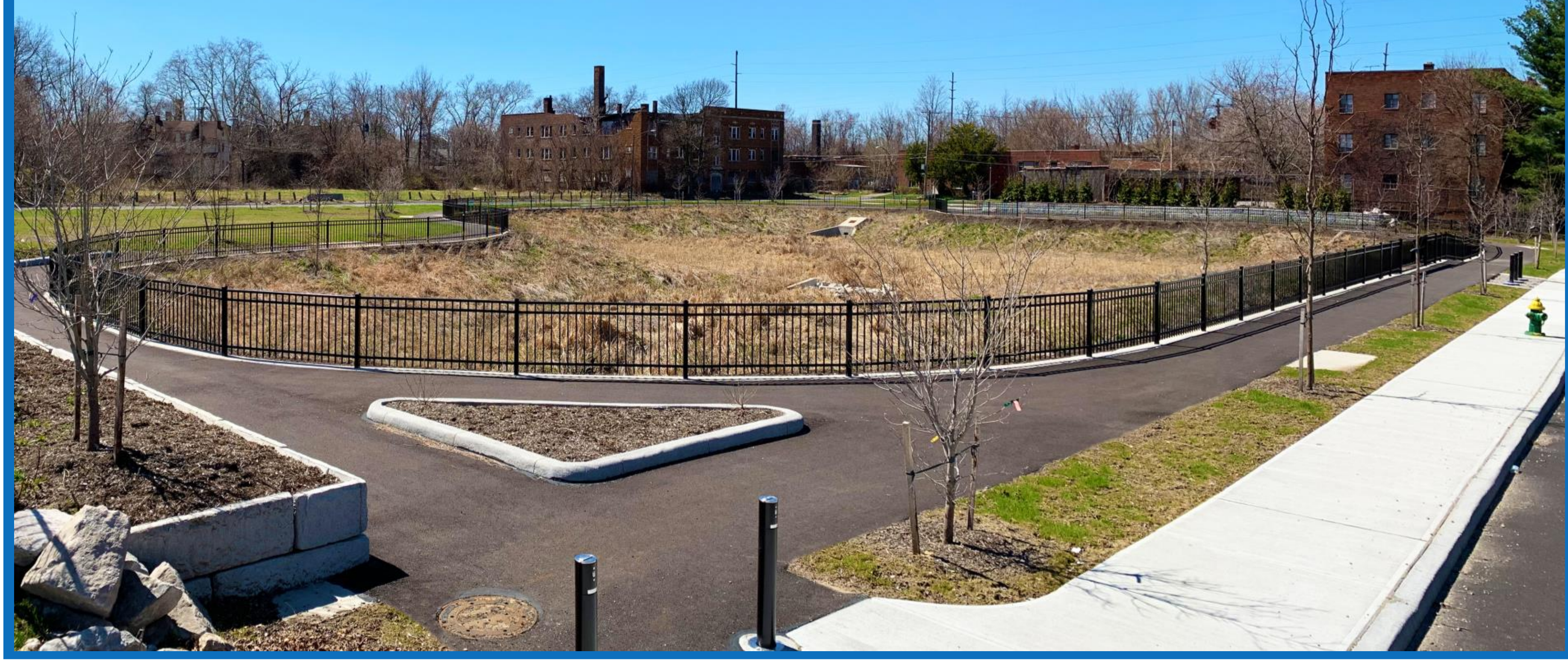
- Seating
- Fencing
- Educational Signage
- Receptacles

E-140th Sewer Separation Project Basins

- 3 Large centralized bioretention basins on separated parcels
- Peripheral “passive” recreation and gathering space amenities

E-140th Sewer Separation Project Basins

- Picket Style Guardrails
- New Streetscapes
- Loop Paths
- Open Green Space



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E-140th Sewer Separation Project Basins

- Outdoor Classroom
- Landscaped Areas
- Accessible Picnic Areas

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Union Buckeye Project Basin – West Basin

- Morgana run pull off
- Bicycle Amenities
- Accessible Picnic Areas

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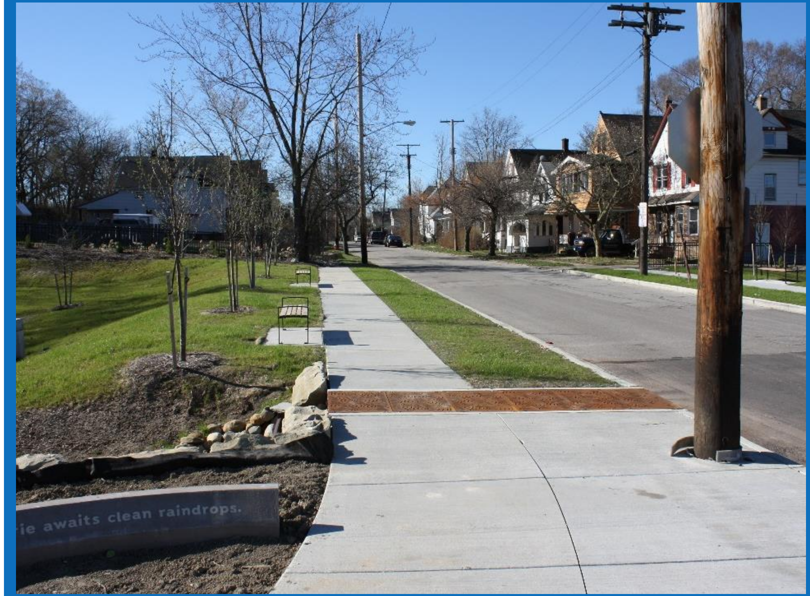
- Access Path
- Bus Stop Seating
- Dense Tree Planting

Union Buckeye Project Basins – Buckeye Basins

- Improved Streetscape
- Public Art
- Sensitivity to Existing Trees



Buckeye Gateway Site

- Existing dewatering site for the New RTA train station
- Catch basin collection along Buckeye Rd and Shaker Blvd

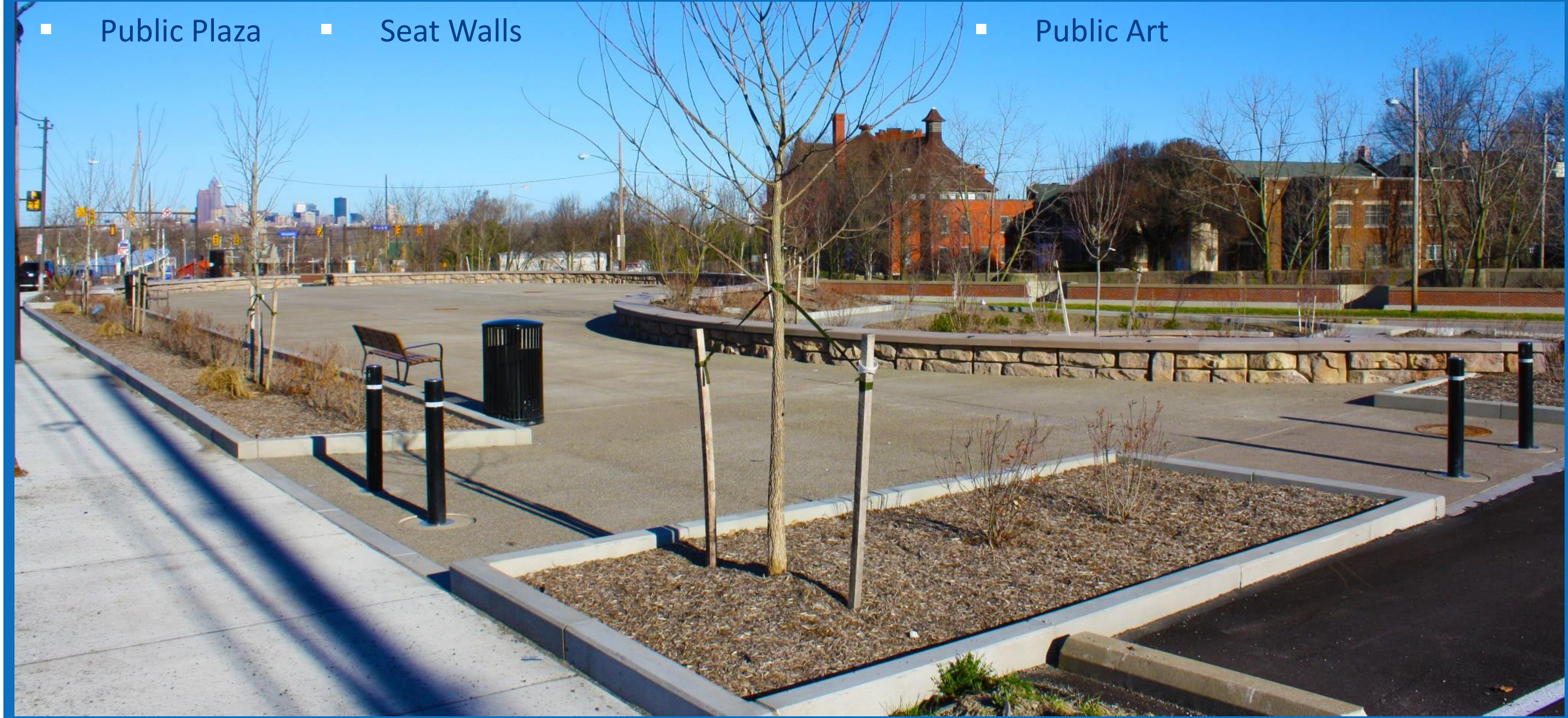
Buckeye Gateway Site

- Subsurface Storage


SUBSURFACE STORAGE CHAMBER
SURFACE FLOW
OUTFLOW TO SEWER
RAIN GARDEN
CB 1
CB 2
CB 3
CB 4
CB 5

Union Buckeye Project Basin – Gateway

- Public Plaza
- Seat Walls
- Public Art



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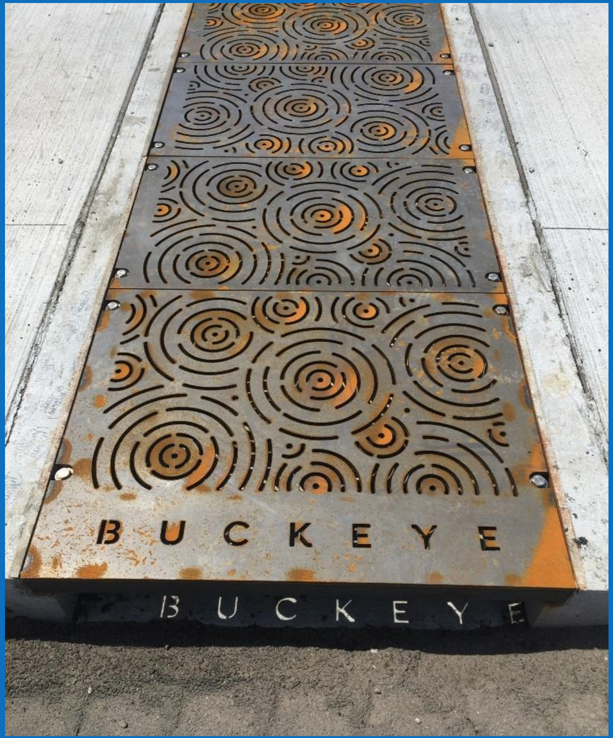
Union Buckeye Project Basin – Gateway

- Seating Areas
- Landscape Beds
- Rain Garden

Public Art – Local Craftsmen

Custom Concrete With Inscribed Poetry

Custom Trench Drains



Public Art – Local Craftsmen

- Custom Bike Rack Sculpture

Custom Water Tower Sculpture

Key Construction Considerations

Pre-construction Meetings

- Mock- Up Meetings
  - Coordinate site elements

Pre-construction Meetings

- Contractor Coordination
  1. Coordinate interdependencies
  2. Establish order of operations
  3. Establish lead times

Soil and pH

1. Bioretention soil balance
   1. Permeability
   2. Growth characteristics

2. Lead time for soil creation

3. Proper pH is essential

4. Limited loose soil exposure
   1. Installation
   2. Planting
   3. Matting

“On – Line” Schedule – Order of Operations

1. Basin establishment
2. Basin Landscaping
3. Hardscape installation
4. Landscape installation

Lessons Learned

- Clear goals and numerous site-specific considerations drive green infrastructure cost-effectiveness.
- A planting design recognizing inundation frequency and maintenance simplicity drives green infrastructure resilience.
- Integration of green infrastructure into the community drives acceptance.
- Implementation success results from close coordination during construction.

Questions?

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Contact us!

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